Journal of Advanced Research in Dynamical and Control Systems, 2018, vol.10, N2 Special Issue, pages 2242-2247

Control of the rotary equipment disbalance by the spectrum of envelope vibroacoustic signal

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

 Rotor equipment (electric motors, pumps, fans, compressors, etc.) is widely used in almost all industries. One of the most common defects of such equipment is the rotor imbalance. The imbalance arises as the result of the action on the centrifugal force and is manifested by the rotor vibration increase in the radial and axial direction. There can be the following imbalance causes: rotor material heterogeneity, manufacturing and assembly errors, the wear of assemblies, the settling of polluting particles, etc. The article considers the method of rotor equipment imbalance control along the spectrum of the vibro-acoustic signal envelope. The method is the following one. Using a bandpass filter, a signal is extracted in a narrow frequency range. Then the received signal is detected (its envelope is allocated) and spectral analysis is carried out. In this paper, we propose the technique to analyze the envelope spectrum of a vibro-acoustic signal. The package of applied programs and an information and measuring complex was developed. Experimental studies were carried out on an axial fan. The imbalance of the fan was created by its attachment of loads to its blade. It was determined that at the absence of fan imbalance only background components with similar levels are present in the envelope spectra. In this case, there is the symmetry of the amplitude distribution in the envelope spectrum relative to their mean value. With the appearance of an imbalance, this symmetry is broken, discrete components appear in the envelope spectrum. The comparison of the central moments of the third order of the envelope spectra makes it possible to determine the degree of the imbalance development.

Keywords

Hilbert transformation, Imbalance, Rotor equipment, Signal envelope spectrum, Third-order central moment, Vibration, Vibro-acoustic control

References

[1] A.A. Gusarov. Balancing of machine rotors: Book 1.-Moscow: Nauka, 2004, 266 p.
[2] A.A. Gusarov. Balancing of machine rotors: Book 2.-Moscow: Nauka, 2005, 384 p.
[3] Barkov A.V., Barkova N.A. Vibration diagnosis of machinery and equipment. Analysis of vibration.-St. Petersburg: SPbGMTU, 2004, 156 p.
[4] Klyuev V.V. Nondestructive testing and diagnostics.-M.: Mechanical Engineering, 2005, 656 p.
[5] Genkin M.D., Sokolova A.G. Vibroacoustic diagnostics of machines and mechanisms.-M.: Mechanical Engineering, 1987, 282 p.

[6] Goldin A.S. The vibration of rotary machines.-Moscow: Mechanical Engineering, 1999, 344 p.

[7] Matyushkova O.Yu., Tetter V.Yu. Modern methods of vibroacoustic diagnosis. Omsk Scientific Bulletin. №3 (123), 2013, pp. 294-299

[8] Abboudab D., Antonia J., Sieg-Ziebab S., Eltabachb M. Envelope analysis of rotating machine vibrations in variable speed conditions: A comprehensive treatment. Mechanical Systems and Signal Processing. Vol. 84, Part A, pp. 200-226

[9] H. Konstantin-Hansen, “Envelope Analysis for Diagnostics of Local Faults in Rolling Element Bearings,” Brüel & Kjær Application Note, BO 0501, 2003.

[10] Berod Geropp. Envelope Analysis-A Signal Analysis Technique for Early Detection and Isolation of Machine Faults. IFAC Proceedings Volumes. Vol. 30, 1997, pp. 977-981.

[11] Alegranzi S. B., Gonçalves J. F., Gomes H. M. Ball bearing vibration monitoring for fault detection by the envelope technique. Blucher Mechanical Engineering Proceedings. Vol. 1, No. 1, 2014, doi: 10.5151/meceng-wccm2012-19745

[12] Folea S. LabVIEW-Practical Applications and Solutions. InTech, 2011, 472 p.

[13] Peter A. Blume. The LabVIEW Style Book. Prentice Hall, 2007, 372 p.

[14] Vankov Yu.V., Ivshin I.V., Zagretdinov A.R., Nizamiev M.F. Software and algorithmic support of the express control for the turbocharger housing of the KAMAZ engine. Bulletin of the Technological University. V.18, No. 5, 2016, pp. 141-143.

[15] A.R. Zagretdinov, E.V. Izmailova, M.F. Nizamiev. Program package for express control of the turbocharger housing for the gas engine KAMAZ // Materials of the reports of the Xth International scientific and technical conference of young experts "Research, design and manufacturing technology of compressor machines" dedicated to B.N. Shneppa's 90th anniversary.-Kazan: "Remark" LLC, 2014, pp. 94-95.

[16] State registration certificate for the computer program No. 2014613685. Software for the analysis of vibroacoustic signals. / Vankov Yu.V., Ivshin I.V., Zagretdinov A.R., Izmaylova E.V., Khalilov R.G. Registered in the Register of Computer Programs on 04/02/2014.

[17] State registration certificate for the computer program No. 2014613692. Software package for express control of KAMAZ engine parts. / Ivshin I.V., Vankov Yu.V., Izmaylova E.V., Zagretdinov A.R., Nizamiev M.F. Registered in the Register of Computer Programs on 04/02/2014.

[18] Saifullin E.R., Zagretdinov A.R., Vankov Y.V., Zagretdinova A.R. Fuel distributor control of an internal combustion engine using Hilbert-Huang transformation. Journal of Fundamental and Applied Sciences. Vol. 9, 2017, pp. 945-956.

[19] Zagretdinov A.R., Gaponenko S.O., Serov V.V. The concept of equipment technical condition estimation on the basis of NNT transformation of vibroacoustic signals // the Engineering bulletin of the Don, 2015, №3, URL: ivdon.ru/ru/magazine/archive/n3y2015/3243.

[20] Thrane N. The Hilbert Transform. Briiel & Kjaer Technical Review, No. 3, 1984, pp. 3-15.

[21] Vankov Yu.V. Low-frequency control methods. The method of free oscillations.-Kazan: KGEU Publishing House, 2003, 140 p.

[22] Ivshin I.V. The development of new low-frequency vibro-acoustic methods to monitor the technical condition of parts, units and mechanisms of weapons and military equipment.-Kazan: Publishing House of the KVVKU, 2009, 170 p.

[23] Zagretdinov A.R., Kondratyev A.E., Gaponenko S.O. Reliability increasing solutions for multilayer composite structures shock-acoustic control. Procedia Engineering "International Conference on Industrial Engineering, ICIE 2017". Vol. 206, 2017, pp. 656-661.

[24] Busarov A.V., Vankov Yu.V., Akutin M.V., Aleksandrovich Yu.P. Automated diagnostic complex to control the riveted connection of the gas turbine blades // Factory laboratory. Diagnostics of materials. 2008. № 12. pp. 37-40.

[25] Zagretdinov A.R., Kondratiev A.E., Vankov Yu.V. The development of the instrument and the technique of shock-acoustic control for multi-layer composite structures // Kazan: University bulletin. Problems of energy. 2013, No. 9-10, pp. 97-104.